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The Technology Assessment Board approves the release of this report. The views expressed in this report are not necessarily those of the Board, OTA Advisory Council, or of individual members thereof.

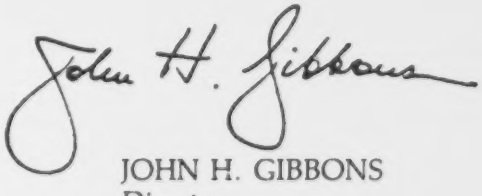
Foreword

Congressional interest in work-related disease and injury led to the passage of the Occupational Safety and Health Act in 1970. The Occupational Safety and Health Administration and the National Institute for Occupational Safety and Health were created to administer that Act, which stated an ambitious goal: "to assure so far as possible every working man and woman in the Nation safe and healthful working conditions."

This report responds to a request from the Chairman of the House Committee on Energy and Commerce and a supporting letter from the Chairman of the Senate Committee on Labor and Human Resources. In this report, OTA examines three main topics: identification of occupational hazards, including the available data on injuries and illnesses; development of control technologies for reducing or eliminating workplace hazards; and the incentives and imperatives that influence decisions to control hazards.

Workers, employers, health and safety professionals, and government officials have all contributed to progress in this field. But improvements can still be made. More concerted effort and better use of existing methods would enhance hazard identification. Further research could improve health and safety control technologies and contribute to their incorporation in U.S. workplaces. Employers' decisions to control hazards might be fostered by changing the incentives and imperatives that affect those decisions.

In preparing this report, OTA staff drew upon the expertise of members of the assessment advisory panel and contractors, as well as other experts in the field of occupational health and safety. Contractors' reports are available from the National Technical Information Service. In some cases, contractors' opinions and viewpoints differ from those in those report. Drafts of the final report were reviewed by the advisory panel, chaired by Dr. Morton Corn; executive branch agencies, congressional staff, and other knowledgable individuals and groups. We are grateful for their assistance. Key OTA staff involved in this assessment were Michael Gough, Karl Kronebusch, Hellen Gelband, Gwenn Sewell, and Beth Bergman. Denny Dobbin worked on this report while on detail from the National Institute for Occupational Safety and Health.



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Preventing Illness and Injury in the Workplace

Occupational hazards are not spread evenly: Some workplaces, such as banks and offices, have few hazards; manufacturing is more dangerous; and mining and construction are comparatively the most hazardous. Certain hazards—some chemicals and forms of radiation—are concentrated in particular places of work; others—powerful machines and fast-moving machinery--are found predominantly in manufacturing and construction. Each uncontrolled hazard is an opportunity for preventing illness or injury.

The exact numbers of workplace-related deaths and injuries are disputed, but OTA estimates that there are about 6,000 deaths annually—about 25 per working day—due to injuries. Depending on how injuries are counted, between 2.5 million and 11.3 million nonfatal occupational injuries occur each year. Each working day there are about 10,000 injuries that result in lost work time and about 45,000 that result in restricted activity or require medical attention. There is so little agreement about the number of workplace-related illnesses that OTA does not take a position on the controversy about the "correct" number. Most deaths and injuries occur one at a time or in small numbers in the Nation's more than 4.5 million workplaces.

OTA finds that controls for health and safety are often developed for specific workplaces and not disseminated to others. This results in duplication of effort as employers faced with the same or similar problems are unaware of successful controls and thus do their own research and development. As well as being economically inefficient, the unshared knowledge about controls may contribute to injuries and deaths.

Occupational hazards accompanied the industrial development of the Nation. In the 19th century, for instance, advances in manufacturing and transportation exposed workers to new hazards, including boilers, train couplings, and powered saws. Scaldings, burns, missing fingers, hands, and arms, and other injuries were the unplanned consequences of work.

Because the relationship between these hazards and injuries is usually immediate and direct, recognition of the hazards is relatively straightforward. The connection between occupational hazards and illness is more difficult to pin down. Although a number of skin and respiratory diseases and some kinds of poisoning caused by metals are definitely associated with work, deciding whether other illnesses stem from workplace exposures is difficult.

This century has seen some examination of the role of the workplace in injury, illness, and death. Motor vehicles used in work are involved in thousands of accidents, resulting in many injuries and deaths. Construction remains a relatively dangerous trade: Powerful earth-moving and erection

machines, high scaffolding, and falling objects are hazards continually faced by construction workers. Painful and sometimes incapacitating repetitive-motion disorders are associated with assembly-line work. Chronic diseases, respiratory conditions, and cancers have been linked with exposures to hazards in a variety of workplaces.

The control of workplace health and safety hazards can be divided into three steps: hazard identification, development of controls, and the decision to control. The first two steps are largely technical and require specialists. The third step involves generalists, managers, and employers, and may actually occur before hazards are fully identified and controls are developed.

The control of illnesses and injuries is not the sole purview of any particular sector of society. Employers and employers' associations, workers and trade unions, universities, and the Federal and State governments have initiated research directed at identifying and controlling hazards, and all have participated in decisions to control dangers that have been identified. Federal involvement has increased over the years, and in 1970 Congress mandated a direct Federal role in all aspects of occupational safety and health, including the setting of mandatory nationwide standards for safe and healthful workplaces.

The Chairman of the House Committee on Energy and Commerce requested that the Office of Technology Assessment undertake a study of technologies to control occupational illnesses and injuries. Both his letter and a supporting letter from the Chairman of the Senate Committee on Labor and Human Resources, called for a broad-based study. In addition to requesting examination of the general subject of control technologies, the chairmen asked for evaluation of the available data and systems for collecting data about work-related deaths, injuries, and illnesses; analysis of incentives and imperatives that influence the decision to control hazards; and a discussion of the opportunities for bettering occupational health and safety as the country enters a period of reindustrialization. Because of the many roles given to Federal agencies by the Occupational Safety and Health (OSH) Act, the activities of the Federal Government are important to understanding developments and problems in designing, developing, and disseminating control technologies, in collecting and analyzing data concerning occupational health and safety, and in providing incentives and imperatives for the adoption of controls.

The report is organized in five parts:

- This chapter summarizes the findings of the report and presents the options for improving occupational health and safety that have been developed during this assessment.
- Chapters 2, 3, and 4 describe the data available on workplace deaths, injuries, and illnesses and discuss methods for identifying health and safety hazards.
- Chapters 5 through 10 consider various control technologies and current efforts to train and educate employers, managers, employees, and health and safety professionals.

- Chapters 11 through 16 discuss the factors that are involved in the decision to control hazards. They review the activities of Federal agencies, the role of economic analysis in decisionmaking, the influence of various incentives and imperatives on decisionmaking, and the opportunities for installing controls during a period of reindustrialization.
- Chapter 17 looks at opportunities for preventing occupational injury and illness in the future.

(The contractors' reports and OTA working papers prepared for this assessment are available through the National Technical Information Service of the U.S. Department of Commerce.)

FINDINGS

Occupationally Associated Deaths, Injuries, and Illnesses

Currently available data are sufficiently accurate and comprehensive to describe the approximate number of occupational injuries and deaths due to such injuries, although these data are still limited and, in particular, offer little guidance for prevention. Data about occupational illnesses are far less accurate and comprehensive.

Deaths

The National Safety Council (NSC, a private organization) and the U.S. Bureau of Labor Statistics (BLS) of the Department of Labor compile data about occupationally related deaths. The most reliable estimates are derived from the BLS Annual Survey, although the survey data do not include the Nation's entire work force. *OTA's adjustment of the BLS figures yields an estimate of about 6,000 deaths annually from occupational injuries, or about 25 deaths each working day.* Occupational fatalities usually occur as isolated events that kill only one or, at most, a few workers and attract little publicity.

Currently collected data can be used to identify the most hazardous industries and the types of accidents that most commonly result in death. The most dangerous industry is mining, which had 44 fatalities per 100,000 full-time workers in 1982. It was followed by the construction, agriculture, and transportation industries (29, 28, and 22 fatalities per 100,000 workers, respectively). Falling below the all-industry average of 7.4 per 100,000 are manufacturing, wholesale and retail trade, and the service industries, all of which had about 4 fatalities per 100,000 workers. The finance, insurance, and real estate industries had the lowest rate of about 2 fatalities per 100,000 workers.

BLS data show that about half of the fatal occupational injuries involve motor vehicles, off-the-road industrial vehicles, and falls. Complementing those findings, an examination of every on-the-job fatality in the State of Maryland during 1 year found that transportation vehicles, nonroad vehicles, and gunshots were the leading causes of fatal injuries. Truck drivers were the most frequent victims of transportation vehicle accidents; most gunshot deaths occurred during holdups.

Injuries

The OSH Act requires employers to keep records of: 1) injuries that caused 1 day or more's absence from work or "restricted activity" at work, and 2) injuries that required medical attention but caused less than a day of missed work. *BLS estimates that in 1983 there were 2.1 million "lost-workday" injuries and 2.6 million "medical treatment" injuries in the private sector, which covers about three-fourths of the work force. Injuries to Federal, State, and local government employees may add another 0.4 million lost workday injuries and 0.5 million medical treatment cases.* Adding those numbers, there were approximately 5.6 million occupationally related injuries. The National Center for Health Statistics (NCHS), which uses different definitions for injuries and prepares estimates for the entire work force, estimates a total of 11.3 million occupationally related injuries in 1981.

BLS and NCHS have separately estimated that workplace-related injuries lead to the loss of, respectively, 36.4 million and 60 million to 70 million days of work annually. Projections from NCHS data are that workers spend about 44 million days in bed because of disability and have over 200 million days of restricted activity. *The NSC has estimated that for 1980 the total costs of work injuries amounted to $30.2 billion.*

The leading types of disabling, nonfatal injuries are overexertions (largely injuries to the back), which occur in many industries. Injuries in manufacturing and construction often involve moving machinery and falls.

Illnesses

Three factors generally contribute to incomplete recording of occupational illnesses: 1) many occupational diseases are indistinguishable from nonoccupational illnesses, 2) the occupational causes of diseases are often not recognized by employers and employees, and 3) diseases with long latencies often occur after employment or exposure has ceased. Thus the BLS Annual Survey estimate of 106,000 such illnesses in 1983 consists mostly of diseases, such as acute dermatitis, that are easily diagnosed and readily connected with workplace exposures. Serious diseases—respiratory and neurologic disorders and cancers—are not generally captured in the BLS records of workplace-related illnesses.

Arguments about the number of occupationally related diseases may obscure the important fact that occupational illness is preventable. For instance, a decade-long debate about the number of occupational cancers has been resolved to most people's satisfaction, and it is generally accepted that occupational cancers represent something like 5 percent (20,000 annual deaths) or less of all cancer deaths. The more important considerations are that workers in some industries have borne and still bear a disproportionate amount of risk and that, once causes of occupational disease are identified, controls can be adopted to reduce risks.

Some Caveats on Available Data

Accurate data are necessary to know the magnitude of the workplace health and safety problem, to target prevention programs, and to assess

the progress in controlling illnesses and injuries. Many factors other than control programs, however, can influence the number of illnesses and injuries. For instance, it has been known for some time that injury rates fall during periods of high unemployment because younger, less skilled workers are laid off first and there is more time for maintenance of plant and machinery. OTA finds that the slowdown in business activity between 1980 and 1983 was the most important factor in the decrease in injury rates during that period. Moreover, national injury rates are related to the level of business activity, going up as business expands, down as it contracts. The Occupational Safety and Health Administration (OSHA), on the other hand, points to these declines as a measure of the success of its new programs that emphasize a cooperative approach between the agency and employers.

Over the last decade the identification and control of health hazards, especially of substances suspected of causing cancer, has received much attention. *Yet the available data about workplace diseases, even if accurate, would not yet reveal any effects from a recent reduction in exposures to carcinogens.* Given the long time between exposure to cancer-causing substances and development of the disease, years or decades may pass before cancer rates are affected. An even greater problem in relying on figures in this area, however, is the inaccuracy of occupational illness data. In 1981, only 234 occupational cancers were reported to workers' compensation systems in 29 States, which contain about half the Nation's work force. That number can be compared to the 4,000 to 12,000 cancers that are estimated to occur from asbestos exposure alone.

Identification of Occupational Hazards

Health

Toxicology, occupational medicine, and epidemiology provide the means for identifying the chemical, physical, or biological causes of occupational illnesses. Identifying an association or possible association between an exposure and disease often ignites a dispute. Employers, who have investments to protect and are perhaps reluctant to accept the idea that employees have been harmed, will require more evidence than workers seeking an explanation for disease among them. It is clear from these controversies that the results of toxicologic texts often lead to further study rather than efforts to control a hazard; that physicians' reports of associations, depending on the disease and exposure, may or may not be accepted as convincing; and that epidemiologic evidence linking exposures and disease is most convincing.

The traditional role of toxicology has been to provide information about the mechanisms of disease causation. *Especially since the late 1960s, however, toxicology has been used to investigate chemicals in an attempt to predict their effects in humans.* The bulk of the effort has been directed toward identifying chemical carcinogens, but some attention is now being directed toward neurologic and reproductive health hazards.

Physicians, both those who specialize in occupational medicine and those in private practice, have identified many health hazards. As an example,

reports of asbestos-associated lung cancer cases in the 1930s were an early clue about that occupational hazard. More recently, a physician noticed an excess of liver cancers in vinyl chloride workers. His observation led to a very successful effort to reduce exposures to that substance. Importantly, physicians speak to workers, and it is workers who are often the first to be aware of hazards.

Epidemiology, the systematic investigation of possible associations between exposures and diseases, has confirmed important suspicions about work-related illnesses. The now universally acknowledged case against asbestos, for example, rests on epidemiologic studies. *Positive epidemiologic results showing that an exposure is associated with a disease are the most convincing evidence of a substance's toxic effect.* Unfortunately, the power of epidemiology to detect small risks is limited, and evidence obtained from toxicology that a substance is toxic can often be neither confirmed nor denied by epidemiologic studies.

The National Institute for Occupational Safety and Health (NIOSH) conducts various epidemiologic investigations and also makes Health Hazard Evaluations (HHEs), short-term studies conducted in response to private and public sector employee or employer requests. HHEs are designed to "determine the toxic effects of chemical, biological, or physical agents . . . in the workplace through medical, epidemiologic, and industrial hygiene investigations." HHEs, which become public reports, have identified and verified the workplace origins of some illnesses.

Information that could be useful for generating and examining hypotheses about relations between exposures and health effects is currently collected by some industries, but it is not clear that the data are often analyzed and the conclusions used to decide upon controls. Even data collected by the Federal Government are not used as much as they could be. Useful data are collected by different agencies, but concerns about individual privacy have restricted linking data from different sources. Although several committees of government scientists have explored ways to remove the restrictions, little has been done.

Safety

The idea that "unsafe workers" are a major contributor to injuries has hampered efforts in injury prevention. In the 1920s, a researcher concluded that nearly 90 percent of injuries were due to workers' "unsafe acts" and 10 percent to "unsafe conditions." Although this ratio of "unsafe acts" to "unsafe conditions" is often referred to, it is not supported by other research. Unfortunately, efforts are still made to separate injury causes into "unsafe acts" and "unsafe conditions," while neglecting the often complex interactions between workers and machines that can lead to injuries. *Additional efforts to apply epidemiologic techniques to injury analysis should be encouraged.*

Technologies to Control Hazards

A generalized model of occupational injury and illness is derived from the public health model of infectious disease transmission. The model has three parts: sources of hazard, transmission of the hazard, and workers. Methods for controlling workplace illnesses and injuries are intuitively simple. Health and safety professionals generally follow a "hierarchy of controls" approach that is related to this general model:

- first, containing the hazard—whether it is a substance or some physical, electrical, or mechanical energy—at its source;
- second, interfering with transmission of the hazard to the worker; and
- third, providing the worker with protective clothing and equipment.

The first two types of controls, controlling at the source and controlling transmission, are commonly called "engineering controls."

Controlling Health Hazards

Control at the source can be accomplished by design or modification of process or equipment or by substitution of less hazardous materials. This approach offers the greatest opportunity for prevention, especially when incorporated in the initial installation of equipment into a plant. For example, redesigned dry-cleaning equipment eliminates the need for someone to transfer chemically treated clothes from one machine to another and thus prevents worker exposure to that particular chemical. Similarly, the very successful control of vinyl chloride exposures involved process changes that reduced the number of times workers had to clean reaction vessels, thus lowering exposures during maintenance operations. An illustration of control by substitution is the use of steel shot instead of sand in abrasive blasting operations. This eliminates worker exposure to silica dust, which can lead to silicosis.

Ventilation is the method most often used to control transmission of health hazards. Local exhaust ventilation uses an air stream to remove contaminants from work areas. Familiar examples of this include laboratory fume hoods and the local exhausts above many kitchen ranges. Similar devices are installed for many types of workplace hazards. General dilution ventilation reduces worker exposure by supplying "fresh" air to the workplace and usually involves the heating/air-conditioning systems of a plant. These systems can be modified to increase the amount of airflow and thus dilute airborne hazards. Recent changes in building ventilation aimed at conserving energy use air recirculation techniques. If not done properly, some of these altered systems may increase worker exposures.

Other ways to control transmission include isolating the source and preventing toxic materials from becoming airborne. Worker exposures to asbestos and cotton textile dust were reduced by enclosing dusty carding ma-

chines. More generally, automating processes and locating equipment in rooms or buildings away from workers reduces exposures. A common technique for preventing dust from becoming airborne is to spray water on the material.

Finally, control at the worker may include administrative procedures, work practices, and the use of personal protective equipment. Administrative procedures include worker rotation among jobs to reduce the number of people exposed full-time, as well as the scheduling of jobs and processes that generate hazards at times when few workers are present. Work practices are simply job procedures and methods that are designed to reduce hazards. Personal protective equipment, such as hard hats and respirators, are described in more detail below.

Controlling Injury Hazards

Workplace injuries generally involve transfers of energy, and thus controlling them could be approached as a task of preventing the transmission of energy. For example, mechanical energy can be transmitted to stationary workers by falling objects, such as bricks on a construction site. Controls could involve securing the bricks so they do not fall, setting up overhead barriers to prevent any falling bricks from striking workers, and issuing hard hats to the workers.

However, the terminology, analytical methods, and procedures of safety professionals have usually differed from those used in controlling health hazards. Safety engineers have tended to use codes, standards, and models of "good practice" that are oriented around particular topics: fire prevention, electrical safety, machinery design, plant layout, etc.

Recommended "good practice" often involves common sense and the personal experience of safety engineers, with relatively little scientific analysis, systematic data collection, epidemiology, or experimental research. In addition, as mentioned, the view that many or most injuries are due to so-called unsafe acts has interfered with the incorporation of injury controls into the design of plant and equipment.

Nevertheless, injury prevention can be incorporated into the design of workplaces. Controls can be introduced to prevent electrical shocks, falling objects, the collapse of buildings and trenchs, and workers falling or being crushed by machinery and equipment.

Manufacturing involves the application of energy to materials to shape them into usable products. Woodworking, hot metalworking, and cold metalworking are three processes with significant hazards. A number of traditional control techniques are available to reduce these hazards. These include the installation of guards to prevent hands and fingers from getting caught in machinery and material from flying out and striking workers. Machinery and processes can also be redesigned to minimize the need for workers to place their arms or legs near moving machinery parts. Interlocks and two-hand controls are available to prevent machine operation when guards have been removed or when a worker's hands are inside the ma-

chine. Finally, personal protective equipment, such as face shields and goggles, are available to reduce the risk of injury from flying objects.

Fires and explosions cause deaths and injuries as well as large economic losses. For both those reasons, efforts to prevent them have resulted in careful attention to good plant design, control of the ignition sources of fires, installation of warning alarms and systems to extinguish fires at early stages, and plans for quick evacuation of burning buildings.

Finally, employers often set up formal injury prevention programs. Because management has the primary responsibility for prevention of work-related injury and illness, a successful program must start with a strong commitment from management. The stronger the commitment at the top, the greater the likelihood of success. Typical management efforts to prevent work-related injury include establishing company policies, incorporating injury prevention into plant design, carefully investigating reported injuries to identify hazards, keeping accurate and comprehensive records, placing workers in appropriate jobs, and conducting safety training for workers and supervisors.

Personal Protective Equipment

Hard hats, safety shoes, and protective eyewear are examples of personal protective equipment. In many cases, especially construction, there are no practical engineering substitutes for such devices. Respirators and hearing protectors guard against hazardous dusts, fumes, vapors, and loud noises.

Obviously, personal protective devices must be worn to be effective, and their successful use requires both that equipment and instruction be made available and that use be properly supervised. There is evidence that safety equipment, such as hard hats and safety toe shoes, is worn when required by employers. Because of the clear connection between those devices and injury prevention, it is reasonably easy to argue that safety equipment will provide immediate benefits. On the other hand, the value of wearing a respirator to protect against a disease that may not manifest itself for several years or a few decades may not be as immediately clear. In addition, most respirators and hearing protectors are uncomfortable and hamper communication, and respirators make breathing more labored. Finally, there is a body of engineering knowledge that can be applied to reducing or eliminating the need to use respirators and hearing protectors.

Unlike engineering controls that are often tailored to a particular workplace, personal protective equipment is manufactured and sold for use at many diverse sites. Some Federal regulations require the use of personal protective equipment. There are, however, no Federal standards for its performance (with the exception of respirators); instead, the Government relies on manufacturers to produce and sell equipment that meets standards adopted by voluntary standards organizations. The American National Standards Institute (ANSI) is the source of most such standards.

In the mid-1970s, NIOSH purchased samples of personal protective equipment and tested them against ANSI standards. Many items failed. For in-

stance, the lenses on 11 of 24 models of a type of protective eyewear splintered or shattered when subjected to the ANSI test for impact resistance; only 4 of 19 models of hard hats passed all the ANSI-specified tests. These results are especially discouraging because the employer who purchases the equipment and the workers who depend on it must rely on the manufacturer to produce a good product.

The standards, often not met, are themselves limited. Plastic lenses are tested for resistance to penetration, whereas glass lenses are not; NIOSH commented that it would expect most glass lenses to fail the test if it were required. Similarly, hard hats are tested for resistance only to vertical impacts. No tests are required for off-center impacts.

The only type of personal protective equipment that is tested and certified by the Federal Government is respirators. NIOSH certifies respirators using laboratory test methods that, in some cases, were developed years ago. Efforts to update the certification requirements have progressed slowly and may take years to complete.

The few tests carried out in the workplace under conditions of normal use show that respirators often do not provide the level of protection expected from the laboratory measurements. The poorer performance may be due to inappropriate use or maintenance or overestimation of performance based on laboratory tests.

The Environmental Protection Agency (EPA) formerly required that hearing protectors be rated for effectiveness. The effectiveness of probably all hearing protectors is overrated because of systematic errors in tests conducted to comply with the EPA requirements.

Hierarchy of Controls

Using engineering solutions to control hazards at their source or in the pathway of transmission is more reliable and less burdensome to the worker than personal protective equipment. Once installed, these controls work day after day with minimum routine intervention beyond maintenance and monitoring.

In keeping with the tenets of professional organizations such as the American Industrial Hygiene Association and the American Conference of Governmental Industrial Hygienists (ACGIH), OSHA had permitted use of personal protective equipment only when engineering controls were not feasible, not capable of reducing exposures to the required levels, or in the process of being designed and installed. This approach has been criticized by some employers who argue that they should be able to substitute personal protective equipment more freely for other types of controls.

In 1983, OSHA announced its intention to reconsider its policy of relying first on engineering controls for airborne health hazards. In a more specific action, OSHA in 1984 proposed a reduction in permissible exposure to asbestos. The agency proposes to allow the use of respirators to attain the new standard. If this regulation becomes final, it will almost certainly provide an argument for primary reliance on respirators in meeting other

standards. Such a change must consider the poor results attained with those devices. OTA's analysis of the literature indicates that respirators provide the protection that is claimed for them only in workplaces that provide scrupulous supervision of maintenance and use. Those conditions are rare. *To turn away from the hierarchy of controls without careful verification of the levels of protection afforded by personal protective devices is likely to increase exposures to health hazards.*

Training and Education

OTA finds that programs to educate workers and health and safety professionals have rarely been evaluated, and that evaluation is necessary to know about their effect. Although not supported by evaluation, there appears to be general agreement that they succeed. Evaluation is difficult because of the difficulty in determining what causes changes in illness and injury rates. Nevertheless, such efforts should be encouraged.

NIOSH funds Educational Resource Centers (ERCs). The centers are to educate occupational health and safety professionals, to offer continuing education programs, to conduct research, and to provide regional consultation services. They are required to provide interdisciplinary education with contributions from occupational medicine and nursing, industrial hygiene, and safety engineering. These requirements set ERCs apart from other health and safety professional education programs.

In 1981, with $12.1 million funding, the ERCs graduated over 780 professionals from degree programs and trained over 12,000 professionals in continuing education programs. Since then the President's budget has proposed cutting the ERC funding to zero, and Congress partially restored funding to $5.8 million in both fiscal year 1982 and 1983. Decreases in Federal funding will probably result in fewer degree and training programs.

Large companies with successful programs emphasize that commitment to control of work-related injury and illness must begin with top management. Despite that widely held opinion, little attention is given to injury and illness prevention in the education of business administration students. One attempt at building manager awareness, the NIOSH and OSHA Project Minerva, is sponsoring a series of meetings for business education teachers to introduce them to the concepts of occupational health and safety and to find ways of bringing those concepts into their courses.

The Nation's *engineering schools* annually train nearly 400,000 students. The accrediting organization for engineering schools requires, in theory, that engineering design courses consider health and safety. These courses, in which students learn the fundamentals of designing plants and processes, would appear to be especially appropriate for learning about the control of hazards. The topic apparently receives little attention, however. At one major engineering school, for example, most faculty interviewed agreed that safety was important, but few hours were devoted to teaching it.

The engineering curriculum, which prepares students for a professional license at the baccalaureate level, is acknowledged as one of the most course-

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laden programs at a university. *Although adding instruction in health and safety is attractive, it is difficult to fit this instruction into the existing engineering curriculum.*

Educating physicians about occupational medicine falls into two categories: general education about occupational disease and injury, and specialized training for practitioners of occupational medicine. Improvements can be made in both areas. It is generally accepted that physicians in general practice fail to recognize the impact of occupational factors on the health of their patients. This poor recognition stems from an orientation toward occupational health that is minimal at best and often nonexistent in U.S. medical schools. To accommodate classes on occupational medicine in the crowded medical curriculum would require that other subjects be dropped, a difficult task.

Postgraduate, specialty training in occupational medicine has traditionally been subsumed under preventive medicine, centered in schools of public health, and sometimes criticized for providing too little clinical experience. The criticism is being muted by the requirement of clinical experience for board certification of physicians in occupational medicine.

Dissemination of Health and Safety Information

Much information about hazards and controls is available from NIOSH, OSHA, health and safety professionals' associations, and the trade literature. The volume and unorganized state of this information impede its use. As a start in making information more accessible, *NIOSH and the National Library of Medicine have established computerized data systems that provide useful information for evaluating workplace hazards.*

OSHA has a consultation program that is designed to provide assistance in hazard identification and control to employers, especially those who run small businesses. It is a potentially valuable tool for the dissemination of information and may be a way to improve job conditions that is less adversarial than the enforcement of regulations through inspections. In fiscal year 1983, OSHA funded consultations in more than 30,000 workplaces.

To date, OSHA has not evaluated the effects of the consultation program on injuries and exposures. Although OSHA urges that employers share the consultants' information with employees, this step is not required, and it is probable that workers are sometimes not informed. Some observers have expressed concern that funding for consultative visits diverts resources from OSHA inspection activities.

Letting workers know about occupational hazards is now facilitated and required by State and local "right-to-know" laws and the recently issued OSHA rule concerning the labeling of containers of hazardous chemical substances. Such information is valuable not only to workers but also to owners and managers who purchase chemicals for their businesses and to doctors and other health professionals.

Incentives and Imperatives That Influence the Decision to Control Hazards

Increased knowledge of hazards and improved controls provide the means for protecting health and safety, but a decision to adopt the controls is necessary for them to have any impact at all. In fact, the first and most important act in workplace health and safety may be the decision to control hazards. At least seven factors may motivate the decision to control:

- employers' enlightened self-interest,
- information on hazards and controls,
- financial and tax incentives,
- workers' compensation and insurance,
- tort liability,
- employees' rights and collective bargaining, and
- regulation.

The first six factors can be viewed as incentives; the last, regulation, is an imperative. OTA finds that while each of these may motivate a decision to control, the influence of all the incentives and the imperative is limited.

Employers' Enlightened Self-Interest

An important motivating factor behind voluntary employer actions concerning health and safety is enlightened self-interest and concern for other humans. Reinforcing such voluntary efforts are reductions in the costs of absenteeism, workers' compensation, or medical care when the decision to control hazards results in fewer injuries and illnesses.

OSHA has recently instituted several programs to encourage voluntary hazard control. In several States, employers are exempt from programed inspections if they receive an OSHA consultation and thereafter correct all serious hazards. OSHA's Voluntary Protection Program also encourages voluntary actions.

Some employers also participate in cooperative efforts to develop voluntary standards that draw upon the collective information and expertise of companies in a particular industry, trade association, or standard-setting organization. *Voluntary standards are an important source of information for employers, workers, and Government agencies, and they may move all companies that agree to them to a common performance level.*

However, voluntary standards are also criticized for being insufficiently protective. Suggested remedies include having additional input from labor unions and the public when standards are drafted. Yet unions and public interest organizations frequently lack the staff and other resources to participate in voluntary standard-setting. Furthermore, they often do not want to participate because of a history of industry domination and the unenforceable nature of voluntary standards.

The pressures of the competitive marketplace substantially limit the ability of individual employers to improve employee health and safety through

voluntary actions. If a company devotes its resources to improving workplace conditions but its competitors do not, the firm can find itself at a disadvantage.

Information on Hazards and Controls

Timely and accurate data are necessary for making decisions, and both Government and private organizations provide information about hazards and controls. Although necessary, information alone may have little influence on decisions to control.

Financial and Tax Incentives

Reducing the costs of purchasing needed equipment and technology can encourage employers to improve health and safety. Four kinds of tax and assistance programs might be useful for occupational health and safety: investment tax credits, accelerated depreciation allowances, direct subsidies, and Government loan programs. Funds from a Government loan program for small businesses have been used for occupational health and safety investments, but that program was abolished in 1981. The other three mechanisms have been used to encourage investments in equipment for environmental protection, but not for health and safety controls.

Workers' Compensation and Insurance

The primary goal of workers' compensation programs is to pay injured workers' medical expenses and to compensate for lost wages. Prevention of injuries and illnesses is a secondary goal. Although workers' compensation programs have probably had a positive effect on *injury* experience, empirical evidence for this has been difficult to gather.

Four factors limit the incentives that workers' compensation can provide for control of hazards. First, all insurance schemes spread losses; therefore, the insurance function of workers' compensation means that employers who cause injuries do not bear their full costs, unless they are self-insured or pay premiums that are directly tied to their injury and illness experience. Second, benefit levels represent less than the full social costs of injuries and illnesses. Third, some injuries and most illnesses are not compensated because a claim is never filed, or they are inadequately compensated because the claim is delayed or denied. To the extent that these factors reduce the fraction of the costs of injuries and illnesses that are borne by employers, they reduce incentives for prevention. Changes in the system that lead to a greater proportion of the costs of illnesses and injuries being paid by employers would enhance the prevention incentives of workers' compensation.

Tort Liability

The last decade has seen spectacular growth in the number of cases in which workers sued firms that manufactured machinery and other products purchased by employers for workers' use. Such suits are generally filed

against "third parties," manufacturers and suppliers, because workers' compensation programs bar suits against employers.

Tort liability has received special attention because of the number of third-party lawsuits against suppliers of asbestos. *If the number of third-party suits increases, and if they are successful for hazards other than asbestos, they may become an important incentive for prevention.* Even so, the number of cases may be limited because it is difficult to produce the degree of proof required by courts in cases of occupational disease.

Employees' Rights and Collective Bargaining

The OSH Act created opportunities for worker participation in health and safety activities. The act provided that workers can:

- request OSHA inspections,
- participate in the conduct of an OSHA inspection,
- participate in any of the stages of a proceeding before the Occupational Safety and Health Review Commission,
- contest the "reasonableness" of the abatement date set by OSHA,
- participate in standards development and the issuance of variances, and
- request a Health Hazard Evaluation from NIOSH.

In addition, the act established a mechanism to protect employees from job discrimination for having exercised any of these rights. This provision prevents discrimination against employees who refuse work that presents an imminent danger of injury, although it probably does not extend to employees who refuse work that the worker thinks presents a health hazard.

Collective bargaining is particularly useful for establishment-specific implementation of controls and for monitoring employer actions. It is severely limited because only about 20 percent of the work force is unionized and because not all unions have sufficient staff expertise in industrial hygiene, injury prevention, or occupational medicine. Moreover, health and safety provisions must compete with other bargaining issues for attention and resources. Some people object to collective bargaining for injury and illness prevention because they believe that health and safety on the job ought to be an employee right, not subject to negotiation.

At least 82 percent of union contracts contain at least one clause related to health and safety according to data collected by the Bureau of National Affairs. Unions can encourage members' participation in health and safety activities, participate in worker education in hazard recognition, provide or have access to technical expertise, and establish mechanisms for dispute resolution between employer and union.

OSHA Regulation

Mandatory Federal regulations are an imperative for the adoption of controls. *Labor representatives insist on mandatory standards and employer representatives, especially health and safety professionals, accept the need for them.* Most of the standards set by OSHA, however, have been criti-

cized by nearly all parties, but for different reasons. Labor groups judge the standards as insufficient to protect health. Business groups see them as nit-picking, excessively stringent, unnecessary, inflexible, and too costly. The criticisms from both sides in part reflect fundamental differences concerning the desirable level and type of Federal intervention in this area.

OSHA's Standard-setting Criteria.—Since 1981, OSHA has used four criteria for decisions on health standards. First, it determines if the hazard in question poses a "significant risk" and warrants regulatory intervention. Second, the agency determines whether regulatory action can reduce the risk. If so, OSHA develops a standard to reduce the risk "to the extent feasible," considering both technological and economic feasibility. Finally, OSHA analyzes the cost effectiveness of various options to determine which will achieve its chosen goal most efficiently.

All OSHA regulatory actions are now reviewed by the Office of Management and Budget (OMB) under Executive Order 12291, which, to the extent permitted by law, requires regulatory agencies to demonstrate that their proposed and final regulations pass a cost-benefit test. Generally speaking, the results of the OMB review and agency responses have not been made public, making it difficult to determine if OSHA decisions have been altered by OMB's cost-benefit review.

OSHA's Record of Standard Setting.—There is dissatisfaction about the length of time OSHA takes to develop, propose, and promulgate new standards or revisions of existing standards. In its first 13 years, through December 1984, OSHA issued only 11 new or revised health standards concerning 24 specific chemical substances and one standard covering exposure to noise. Standards for two of the substances and noise were overturned by the courts. Twenty-six new or revised safety standards were completed. In addition, broader regulations concerning employee access to records, a "generic" policy concerning the regulation of carcinogens (under which no substance has been regulated), and the labeling standard were issued.

In part because of the slowness of OSHA standard writing, *many OSHA standards seriously lag behind recommendations and voluntary standards issued by professional societies and voluntary standards organizations.*

Most current OSHA health standards are based on the exposure limits published by the American Conference of Governmental Industrial Hygienists in 1968, and most safety standards rely on American National Standards Institute publications of the 1960s. Those standards were adopted in 1971 under a section of the OSH Act which gave OSHA authority to adopt established Federal standards and national consensus standards. ACGIH annually updates its limits, including standards for additional chemicals, and often recommends stricter exposure limits. OSHA often does not follow suit.

OTA finds that ACGIH exposure limits and NIOSH recommendations, overall, are stricter than the OSHA standards. In addition, the 1968 ACGIH list covered nearly 400 substances. The current ACGIH list covers over 600 substances, but OSHA's list—with a handful of additions—remains essen-

tially the same as ACGIH's 1968 list. A mechanism for timely and efficient OSHA consideration of new ACGIH exposure limits and NIOSH recommendations might prevent OSHA from lagging behind professional recommendations.

OSHA Inspection and Enforcement.—*A regulatory strategy will succeed only if the agency's enforcement efforts have adequate resources.* For most establishments the probability of a routine OSHA inspection is very low (there are about 160,000 inspections annually in a total of 4,600,000 workplaces). Most inspections take place in manufacturing or construction. But even in those industries, on average, a plant or site will be inspected only rarely. For example, the typical manufacturing establishment can expect to be inspected once every 6 years. In addition, even if an employer is found not to be in compliance, the fines issued by OSHA are small, especially when compared with the costs of many types of controls. For example, the average proposed penalty for employer violations that threaten "death or serious physical harm" is less than $200.

The current administration has implemented a number of changes in inspection and enforcement. A new type of inspection examines only the employer-maintained injury records if the firm's injury rate is below the national average for manufacturing. In addition, the number and percentage of inspections with "serious" and "willful" violations has fallen, and the total dollar amount of proposed penalties has been reduced substantially.

Other new OSHA policies encourage area directors and employers to "settle" citations by reducing or eliminating penalties in return for an employer's promise to abate the hazard and to comply with OSHA regulations. These changes may decrease the contentiousness of some OSHA proceedings. On the other hand, they may have further reduced an already weak regulatory effort.

OSHA's Effects.—The impact OSHA can have on injury rates is constrained by the small size of the OSHA regulatory effort, which can inspect less than 4 percent of the Nation's workplaces annually. Most evaluations have searched for OSHA's effects on total injury rates, which could be masking the success of the agency in preventing certain specific types of injuries as well as possible differences in the effectiveness of each area office of OSHA and of the 25 jurisdictions operating "State programs."

The research results are mixed. *Several researchers have found favorable, but generally small, changes, implying that OSHA's activities have reduced injury rates. Other researchers have not found any significant correlation between OSHA activity and workplace injuries.*

Currently, OSHA points to decreasing injury rates for 1980 through 1983 as evidence that the agency's new regulatory approaches are paying off. However, changes at OSHA could not fully account for the declines, for they were not instituted until 1981, more than a year after the drop in rates began. Moreover, as indicated earlier, the economic recession, including

increased unemployment and a shift away from "smokestack industries," is the most important factor behind this decline.

There is some evidence that several OSHA regulations have had a positive effect on exposures to health hazards. The best known case is vinyl chloride. Exposures declined dramatically after the issuance of a more stringent OSHA standard. Substantial declines have taken place in asbestos exposure levels, perhaps due to OSHA efforts, but more likely due to fears of tort liability suits.

A study commissioned for this assessment found substantial decreases in lead levels in workplace air and even more marked reductions in lead levels in employees' blood in the years since OSHA's new lead standard was promulgated. Another study commissioned by OTA found substantial decreases in exposures to cotton dust following the introduction of a new agency standard. The number of workers exposed to levels above the new, tighter exposure limit for cotton dust has been halved in the short time since the standard came into effect. Several textile mills appear to be in complete compliance, while others expect to be in the near future.

Measuring OSHA's impact is difficult. To detect the impact of a small Federal program on something as large as the Nation's entire work force might be asking too much. Regarding workplace-related illnesses, even if the data were reliable, it is too early to expect that OSHA regulations would have much impact on occupational disease. On the positive side, however, *OSHA standards for vinyl chloride, cotton dust, and lead have clearly reduced workplace exposures. Furthermore, increased productivity accompanied compliance with both the vinyl chloride and cotton dust regulations.*

Reindustrialization and Workplace Health and Safety

Over the years, the process of industrial change and renewal has led to improvements in occupational health and safety. *Although quantitative estimates are lacking, to some extent the reported declines in injury rates dating from early in this century may be due to the installation of modern, safer plants and equipment. A second factor may be general shifts in employment away from industries and operations with greater hazards.* Similarly, in some particular cases, exposures to health hazards have declined because of increased mechanization, but it is not clear whether exposures to health hazards overall have decreased, remained the same, or increased.

Thus, through the process of industrial change, health and safety can improve without anyone's explicitly "intending" it. In addition, some changes in the workplace have taken place because of employers' desires to minimize the threat of fire and explosion or to reduce the downtime of plant or equipment. Some changes that lower the threat of property damage or "down time" also reduce exposures to toxic agents or the risk of injury.

If this country is entering a period of reindustrialization, many opportunities will be available to improve health and safety. As new plants are built, employers may take advantage of opportunities to install controls as part of initial construction, when they can be put in at lowest cost. If

the Government provides economic incentives or financial assistance to firms as they modernize, it can consider methods to encourage the installation of controls. Some of the incentives already mentioned—including tax breaks and direct financial subsidies, as well as possibly timing new OSHA regulations to coincide with industrywide changes—might be useful during a period of reindustrialization.

OPTIONS FOR CONTROLLING WORKPLACE HAZARDS

Data and Hazard Identification

Increasing the Usefulness of Current Data Systems

Identifying workplace health and safety hazards is the first step in reducing occupational morbidity and mortality. Certain changes in Federal data collection efforts can make epidemiologic investigations.

Mortality Surveys.—One nationwide study of death certificates to examine associations between industry and occupation and mortality was done in the 1950s. Since then, epidemiologists in the States of Washington and Rhode Island have conducted statewide studies. These are valuable not only for identifying high risks associated with some types of work but also for indicating occupations and industries that do *not* present high risks. Yet statewide mortality analyses cannot be representative of the Nation as a whole and lack the statistical power that would be present in an analysis of data for the whole country. Nationwide mortality analyses would provide important leads for further study to pin down associations between work and various causes of death, as well as valuable information about hazards in occupations that are scattered across the country, e.g., carpenters or butchers.

Currently, NIOSH and the National Center for Health Statistics provide instruction and assistance to a few States that are conducting mortality surveys. A collaborative effort between NCHS and NIOSH would probably best accomplish the task of carrying out *nationwide* mortality surveys.

Option 1: Congress could provide funds and personnel for an NCHS/NIOSH collaborative effort to produce accurate coding of industry and occupation information on death certificates. That information could then be used to produce mortality analyses for occupations and industries either in:

- *the few States that are establishing mortality surveys or*
- *nationally.*

The National Death Index.—Information on death certificates is essential to any epidemiologic study investigating causes of death. When supplied with someone's name and date of birth or Social Security number, the National Death Index (NDI), a service of the NCHS, can tell epidemiologists whether that person has died and where the death certificate is located. Until NDI was established, epidemiologists had to contact every department of vital statistics to locate the death certificate. Quite simply, the

NDI reduces the number of such inquiries from more than 50 to 1, although each certificate must still be obtained from the office of vital statistics that holds it.

The NDI would be more useful if it supplied all the information encoded upon death certificates. Were it to be modified to do that, epidemiologists could obtain all vital information for mortality studies from a single inquiry. The benefits of such a change would be to speed up studies and reduce their costs. Such a change would increase the work load at NCHS associated with the NDI and require some system whereby State departments of vital statistics could still receive revenue for supplying information.

Option 2: The National Death Index could be modified so that all information collected on death certificates can be made available from it.

Addresses From Internal Revenue Service Records.—Epidemiologic studies frequently require investigators to interview subjects of the study or their families. One impediment to such efforts is the difficulty of locating people. Internal Revenue Service (IRS) records are a reasonably complete source of recent addresses, but only NIOSH and some other Federal agency scientists and persons working on contract to NIOSH can obtain addresses from IRS.

There is some confusion about who can use this "NIOSH window" and clarifications about this are needed. In addition, it may be desirable to allow a wider spectrum of researchers to obtain addresses from IRS. Any expansion of the window would require safeguards so that addresses received this way are used only for epidemiologic studies.

Option 3: Congress could direct the Federal agencies to define clearly who can obtain IRS-held addresses and create procedures to allow a wider spectrum of researchers to obtain addresses from the IRS for use in locating persons for epidemiologic studies.

Linking Federal Data Systems to Facilitate Epidemiologic Studies.—The records systems of the Census Bureau, Social Security Administration, Veterans' Administration, OSHA, and NIOSH could be linked together to provide information about medical conditions, work history and exposures, and the current address in a single file. Such a link could improve epidemiologic studies; but it increases also the possibility of invasion of a person's privacy. The option suggested here is intentionally vague because of the delicate balance between improving our capacity to understand disease and protecting citizens' privacy.

Although epidemiologists are convinced of the value of linking together data systems, few efforts to do so have been approved. "On Occupational Cancer Estimation," the recent report of the Department of Health and Human Services' Committee to Coordinate Environmental and Related Programs, suggests some options for linking data systems.

Option 4: Congress could encourage consideration of various proposals to link together Federal data systems for use in epidemiology.

Injury Investigation

OSHA investigates 1,500 to 2,000 accidents involving fatalities or five or more hospitalizations each year. Unfortunately, little attention has been paid to using the collected information to prevent future accidents, and for many years it had only gathered dust in OSHA's files. The agency has conducted some limited analyses of these investigations, has initiated a small effort to distribute summaries of construction accidents to labor unions, trade associations, and other organizations, and is developing a new data system to provide information collected during accident investigations. Complementing these activities, NIOSH has begun detailed investigations of a small number of fatal injuries. In addition, the BLS has obtained information on some types of nonfatal injuries through questionnaires completed by injured workers.

Option 5: Congress might direct OSHA, NIOSH, and BLS to devote additional resources to investigating fatal and nonfatal injuries, with the objective of developing information useful for preventive efforts.

BLS Annual Survey

The BLS Annual Survey, which collects information from employer-maintained logs of injuries and illnesses, is the best source of information about occupational fatalities and nonfatal injuries. Since 1981, employer-maintained injury records and the results of the BLS Annual Survey have been used to grant exemptions from OSHA inspections. Because of this reliance on the data, assessing the reliability of the responses would be prudent.

In the early 1970s, BLS conducted onsite evaluations of a sample of employer responses to the Annual Survey to verify their accuracy. This "Quality Assurance Program" has not been repeated since 1976.

Option 6: Congress could direct OSHA and BLS to conduct a new "Quality Assurance Program" to determine the accuracy of employer-maintained injury records.

Toxicology

The Federal Government, especially through the National Toxicology Program and the National Center for Toxicological Research, is supporting large-scale efforts to improve toxicology so that results will be more predictive of human effects and more readily accepted in the setting of standards. The Toxic Substances Control Act mandates the submission to EPA of information about "substantial risks" to human health that are identified by companies. This section of the statute and the act's requirement that companies notify EPA of available toxicologic information before new chemicals are introduced into commerce are important in protecting workers' health. This assessment suggests no particular options regarding toxicology, but it draws attention to the importance of those programs.

Improved Control Technologies

NIOSH-Supported Research on Controls

Provided with sufficient resources, NIOSH, through vigorous grant and contract programs, could encourage the application of the techniques of engineering, epidemiology, ergonomics (human-factors engineering), industrial hygiene, and other disciplines to the development of innovative hazard control methods. Increasing NIOSH's research in control technologies even five- or tenfold need not require a proportional increase in NIOSH staff. Most of the research could be done in private sector and university laboratories.

Increased research and development of control technologies would enable the Federal Government to provide new information to improve safety and health. It might also improve cooperation between the Federal Government and occupational health and safety professionals in the private sector. Research in control technologies represented only 12.8 percent or about $7.4 million of the NIOSH budget in fiscal year 1983. Three general research areas could benefit from additional funding: engineering controls, personal protective equipment, and new production techniques.

Workplaces built some years ago with little attention to occupational health and safety often incorporated few injury and illness controls when they were constructed. Instead, controls—if they are used at all—are added later as retrofits. Additional work is needed to develop general principles for designing controls into plant and equipment in order to increase effectiveness and minimize interference with production. Another goal could be improved control at reduced cost. Lower costs might reduce employer and manufacturer resistance to the installation of controls and the burdens of regulatory standard setting and enforcement.

Research on personal protective equipment should develop reliable and comfortable devices and methods to assess efficacy in "real-world" conditions. Research on respirators is particularly needed, but investigations of other kinds of personal protective equipment are also important.

A third priority area for research in worker health and safety is new technologies. The hazard potential of new processes, procedures, equipment, and techniques needs to be evaluated, and attention paid to the development of controls. Early attention to hazards will provide health benefits to workers; moreover, lower costs are associated with building hazard control into the technologies at first rather than having to retrofit later.

Option 7: Congress could expand support of NIOSH research and demonstrations in control technologies, using both NIOSH staff and resources as well as grants, cooperative agreements, and contracts. This expanded research and demonstration effort could be directed at four different areas:

- *fundamental engineering research, directed at finding generalizable principles for health and safety controls;*
- *applied research and demonstration projects concerning improved engineering control techniques;*

- *research in improved personal protective equipment;*
- *efforts to track emerging industries and new plants, evaluate hazards, and offer advice to firms engaged in new technologies.*

Private Sector Research

Much research, especially that oriented towards the development of controls for particular installations, is conducted by employers, equipment manufacturers, and the insurance industry. Their efforts have produced successful solutions for many occupational health and safety problems. To the extent that they have the appropriate expertise, employers and manufacturers should be eligible for NIOSH research grants and contracts.

Certification and Regulation of Personal Protective Equipment

All types of personal protective equipment pose similar questions: What kinds of tests for effectiveness should be required? When should the tests be done—before or after marketing? Who should conduct the tests? How should test results be used?

Option 8: NIOSH could be given resources to establish procedures to test and certify some or all types of personal protective equipment; the agency might:

Option 8A: establish a program of ***premarket testing*** *that includes, at a minimum, appropriate laboratory evaluation of personal protective equipment, and, as soon as possible, testing and certification to reflect real workplace situations;*

Option 8B: conduct ***postmarket surveillance*** *to collect reports of equipment failure and defects, and to investigate those reports; or*

Option 8C: explore alternative arrangements for ***both premarket testing and postmarket surveillance*** *of personal protective equipment.*

These arrangements could include different combinations of self-testing and certification by manufacturers, testing and certification by independent parties, "spot-check" testing by NIOSH, and full-scale testing by NIOSH.

Although employers and employees rely on effectiveness labeling to select equipment, those figures often overstate actual effectiveness. For example, OSHA instructs its compliance officers to assume that hearing protectors provide only 50 percent of the laboratory-measured protection.

Option 9: Congress could provide OSHA and NIOSH with resources to develop, collect, and disseminate information on "real-world" effectiveness of currently available personal protective equipment.

Education, Training, and Information Dissemination

The Federal Government provides in-house training to its own and other employees and grant support for various education and training programs. One example of an in-house activity is the OSHA Training Institute, which

provides continuing education to Federal and State OSHA staff (principally inspectors) and, to a limited extent, to individuals from the private sector. Grant-supported activities are split: OSHA has concentrated on employee and employer training, whereas NIOSH has general responsibility for the education of professionals.

Workers and Supervisors

Since 1978, the OSHA New Directions Program has awarded grants to labor unions, trade associations, universities, and nonprofit institutions for developing and conducting training and education programs. The focus has been worker training, although a number of New Directions grantees have also trained supervisors and produced educational materials useful to supervisors, managers, and workers.

The New Directions Program, although not so well evaluated as it could be, is seen as a success by many health and safety professionals. Currently the grants that were supported by transfer of money from the National Cancer Institute to OSHA are being evaluated, and other assessments could be encouraged. The characteristics of good and poor projects should be publicized and the funding level of the New Directions Program, which has been decreased, could be reconsidered. Aiding local or industry-centered organizations to find solutions to local problems provides a direct approach to health and safety problems.

Option 10: Congress might increase Federal support for occupational health and safety education and training, possibly through the New Directions Program, by:

- *involving unions, workers' organizations, and trade and educational associations in education and training through the provision of grants to develop informational and educational materials and to hire professional health and safety staff;*
- *supporting education of supervisors and managers in occupational health and safety through programs directed at providing educational materials to employees.*

The Federal Mine Safety and Health Act of 1977 requires mine operators to provide certain specified amounts of safety training to workers. Some OSHA standards require employers to provide worker training concerning specific hazards, but there are no requirements for instruction or training in most occupations. However, in the absence of any requirement, some employers provide health and safety training. Furthermore, some collective bargaining agreements specify that all workers receive some training and that advanced instruction be provided to worker members of health and safety committees.

Option 11: Employers might be required to provide a certain minimum level of health and safety training to their entire work force.

Health and Safety Professionals

NIOSH training grants to universities support two activities: academic programs that train individuals in a single specialty, and Educational Re-

source Centers, which provide complete programs. Many health and safety experts believe that these funds have been well spent, increasing the number of graduated professionals and enhancing the abilities of professionals through continuing education. On the other hand, there has been only limited evaluation of these programs or the actual impact that the increased number of professionals has had on worker health and safety.

Funding for these programs has been reduced in recent years and the current administration has proposed complete elimination of the ERCs. Cutbacks in Federal funding in this area are likely to reduce the number of trained professionals.

Option 12: Congress could continue to fund training of occupational health and safety specialists, including the Educational Resource Centers, through the NIOSH training grants program.

Engineers, Physicians, and Managers

The disciplines of engineering and medicine have a marked impact on occupational health and safety even though most practitioners in these disciplines are not specialists in workplace health and safety. Neither general-practice physicians nor engineers receive significant instruction about occupational hazards and controls. For physicians, the prime need is training to recognize the impact of occupational exposures on health. Engineers need to understand the nature of occupational hazards and to learn the fundamental design techniques useful for prevention of work-related illness and injury. In addition, managers play an important continuing role in decision-making about health and safety.

Some starts have been made (and some abandoned) to extend information about safety and health to physicians, engineers, and business administration educators and students. The Department of Health and Human Services supported some efforts to educate physicians in environmental and occupational health in several medical schools in the late 1970s, but funds are no longer available. NIOSH has sponsored a series of workshops on the topic of engineering education concerning health and safety.

Option 13: Congress could provide support for and encourage:

- *introducing occupational medicine in medical school course work;*
- *introducing or expanding occupational safety and health into engineering school curricula;*
- *introducing or expanding classes about occupational health and safety in business administration courses.*

For example, grants through NIOSH or the National Science Foundation might be used to develop training modules for integration into existing courses.

Expanded Information Services

The OSHA consultation program, which was instituted to provide health and safety evaluations to businesses, especially small firms, is a relatively popular program. One possibility is to expand the program to provide con-

sultation to a greater number of employers as well as to employees and unions. This would require funding, as well as the creation of procedures for providing these services.

Option 14: Congress could expand the OSHA consultation program by:

- *providing increased funding for OSHA consultation;*
- *directing OSHA to explore methods to encourage employers to share this information with employees and their representatives;*
- *expanding the consultation program to provide this service to employees and unions.*

Insurance Industry Research

Representatives of insurance companies visit more plants than OSHA is able to inspect, and many employers, especially small firms that lack full-time health and safety personnel, rely on the advice of their insurers' loss-control specialists. The establishment of an institute similar to the Insurance Institute for Highway Safety might facilitate the dissemination of industry-collected information on occupational health and safety. No option is proposed because there would be no Federal role in such an institute.

Computerized Information Systems

There are many useful collections of data. For instance, NIOSH produces and collects information about toxicity, assessment of control technologies, and product testing; OSHA collects information about hazards and controls during inspections, consultations, and courses. Combining information from some or all of these sources would produce a data system for use by designers, engineers, workers, employers, and health and safety specialists. Users could be charged for services to defray expenses and possibly to make the service self-supporting.

Option 15: The Federal Government could provide grant or contract money to apply computer technology to the collection and dissemination of occupational health and safety information.

Incentives and Imperatives

Voluntary Implementation of Controls

Voluntary employer efforts to improve health and safety are very important. OSHA has initiated a program to encourage such efforts, and NIOSH has often persuaded employers to control hazards that are not currently subject to OSHA regulations. Attempts to encourage "voluntary protection" must be kept in balance, however, with the standard setting and enforcement required by the OSH Act.

Option 16: Congress could direct OSHA and NIOSH to increase the attention devoted to encouraging voluntary efforts and to publicize the firms that have exemplary programs in health and safety.

Workers' Compensation Programs and Tort Liability

Workers' compensation programs, administered by the States, have been credited with contributing to the prevention of injuries and illnesses. There is reason to believe that this may be true for occupational injuries, although data to support this conclusion are limited. For illnesses, data are even more sparse, and the programs offer fewer incentives for prevention of illness than for injuries.

Most potential lawsuits by employees against their employers for occupational injuries and illnesses are barred by the statutes that created the State workers' compensation systems. It has been suggested that this prohibition be eliminated in some circumstances, but this would involve major changes in workers' compensation laws.

Congress is considering legislation to provide compensation for the victims of asbestos-related disease. This proposal is a response to perceived problems in both the workers' compensation and tort liability systems.

Prevention should be considered in any changes in compensation. In general, a compensation system should be designed to encourage prevention. If Federal revenues are used to supplement occupational disease compensation funds, the Federal contribution might be accompanied by a requirement that companies take concrete steps to prevent future cases of disease—a suggestion that is admittedly hard to implement. Since OSHA would almost certainly already be regulating any hazard important enough to require a Federal contribution to compensation, it is not clear what additional requirements might be imposed on companies that benefit from compensation legislation. But it is also important to consider carefully any changes in either compensation or tort liability to guard against changes that might weaken incentives for prevention.

Labor-Management Committees

Labor-management health and safety committees exist in many U.S. workplaces, in both union and nonunion shops. They offer an avenue for sharing and conveying information about hazards and controls. OSHA currently supports the formation of joint committees in companies that participate in the OSHA Voluntary Protection Programs.

Option 17: Congress could encourage the formation of labor-management committees by:

- *directing that OSHA expand its Voluntary Protection Program;*
- *increasing OSHA funding for training, consultation, and other technical assistance to workplaces with labor-management committees.*

The Role of OSHA

Updating OSHA Regulations

It is well known that OSHA lags behind professional health and safety organizations and consensus standards in responding to new information about health hazards. The agency upgrades its regulations through the same

time-consuming rulemaking procedure it uses to promulgate new regulations, and changes are often opposed.

OSHA considers NIOSH recommendations about exposure limits, but has taken few regulatory actions based on NIOSH criteria documents. Requiring an OSHA response to NIOSH recommendations would ensure that the regulatory agency considered the research agency's findings, but making it mandatory for OSHA to regulate on the basis of NIOSH recommendations might not be useful. The Mine Safety and Health Administration (MSHA) is currently required to respond to certain NIOSH recommendations. However, NIOSH has sent no such recommendations to MSHA, perhaps because of the direct tie between recommendation and regulation.

Option 18: Congress might direct OSHA to develop methods to respond to changes in national consensus standards and other professional recommendations.

Option 19: Congress might require OSHA to consider NIOSH recommendations for new or more stringent controls within a fixed period of time—say, 2 or 3 years. At the end of that time, OSHA could adopt, modify, or decide against adopting the recommendations, but it would have to respond or be subject to suit.

Without changing the current system of standard setting, OSHA inspectors could provide information to both employers and workers concerning professional recommendations. Although it would not be legally binding, employers might take actions based on this information.

Option 20: OSHA inspectors could be directed to provide information (to employers and employees) on current NIOSH recommendations, professional organizations' recommended exposure limits (such as ACGIH's, which are updated annually), and voluntary standards whenever these recommendations and standards would affect the hazards found in particular workplaces.

Standard Setting

Despite the fact that it did not succeed, a recent effort to negotiate a standard for benzene should provide much valuable information about the feasibility of using negotiations in standard setting.

Option 21: Congress might encourage OSHA to study possible procedures for negotiation during standards development and implementation. These procedures will have to assure the adequate representation of all affected parties.

In the setting of health standards, OSHA has generally moved substance-by-substance. Each proposed health standard can be, and most have been, opposed. OSHA has made three attempts to establish "generic standards." The agency promulgated a "cancer policy" in 1980 that defined what data would be necessary and sufficient to make a decision about a substance being a carcinogen and the nature of the standard that would then be issued. The "access to records regulation," a generic standard applying to all employer-held health and safety records, guaranteed workers the right to

inspect records and required that employers retain them. The recently promulgated labeling, or "hazard communication" standard also has generic aspects.

Generic standards offer greater efficiency in that matters of a general nature can be settled once rather than being renewed for every specific case. There are, however, difficulties in issuing broad regulations that are to apply in many situations. Moreover, there is no guarantee that generic standards will be used. For example, no carcinogens have been regulated under the agency's "cancer policy."

Possible areas for generic standards include exposure monitoring and employee training. It may also be possible to issue standards that deal with groups of, rather than single, substances.

Option 22: OSHA could be encouraged to issue generic standards to supplement substance or hazard-specific rules.

OSHA Enforcement Activity

No other OSHA activity stirs up so much emotional fervor as its inspection and enforcement activities. Many businesses object to inspections as being nit-picking and unrelated to employee health and safety. Employees and unions, on the other hand, believe that inspections are essential to worker protection and are concerned that OSHA devotes insufficient resources to them and that inspectors are not vigorous enough in enforcing legal requirements.

Whatever the number of inspections, some violations are found and punished by fines. In most cases, the fines levied by OSHA are less than the costs of controlling hazards. One possibility would be to increase fines to levels equal to the actual costs of implementing controls. Or fines might be based on a calculation of the amount necessary to have a deterrent effect.

In some cases, fines equal to the costs of control would exceed the maximum levels established in the OSH Act. Therefore, the law may have to be changed to allow higher penalties. Of course, higher penalties will raise the number of contested OSHA actions and the general level of controversy in this field.

Option 23: Congress could consider what the appropriate level of OSHA enforcement activity should be; it could then either:

- *continue the current levels of personnel and funding for inspection activity and the new policies concerning inspection targeting and citation settlement; or*
- *increase the number of inspectors, and the level of fines, and change the targeting and settlement policies to increase incentives for compliance.*

Other Federal Actions Affecting Hazard Control

Various tax and financial assessment programs—investment tax credits, accelerated depreciation, government loan programs, and direct subsidies—might encourage employers to install control technologies. However, all

these programs have disadvantages. First, they would reduce Federal tax revenues or increase budget outlays. Second, depending on their design, tax-based incentives can be relatively inefficient mechanisms because firms that would have installed controls, even in the absence of the program, would now receive a tax subsidy. Third, there will be difficulties in dividing the purchase price of equipment between features that are health and safety controls and those that are part of the equipment for purely productive reasons.

Option 24: Congress might enact a tax and financial assistance program to assist businesses in improving occupational safety and health.

As the United States considers its economic and industrial policies, it is unclear what balance is to be struck between updating old-line industries and focusing on new industries. In the future, the Federal Government may play an active role in the "reindustrialization" or "deindustrialization" of America.

If explicit Federal policies are created, they may include discussions and agreements among interested businesses, unions, communities, and others, as well as Federal loans and financial assistance. Information could be developed concerning the health, safety, investment, and productivity needs of various industries. One possibility would be to provide financial assistance for health and safety, as well as for productivity investments.

The general disadvantages of these approaches include the concern that health and safety will "take second place" to the push for productivity. In addition, many object to any Federal role in coordinating or financing industrial investments.

Option 25: If the United States makes available funds or tax incentives for the building or rebuilding of industry:

- *controls for health and safety hazards could be* **eligible** *for the same funds or tax breaks as other construction costs;*
- *companies receiving reindustrialization assistance might be* **required** *to design health and safety into their new plant and equipment, either to meet existing standards or to achieve lower exposure levels or safer processes.*

It has been suggested that regulatory requirements have diverted resources from "productive" uses and contributed to economic slowdowns. However, in at least two cases (standards concerning vinyl chloride and cotton dust), new production processes were developed that both benefited worker health and improved productivity. Fitting regulatory activities to productivity concerns can be achieved in two ways: either delaying regulatory requirements until they coincide with planned modernization or using health and safety regulations to "spur" productivity improvements.

Option 26: Congress could direct OSHA to:

- *delay the required use of engineering controls, so that the installation of these controls coincides with modernization of an industry;*
- *use health and safety regulations to encourage plant and equipment modernization.*

Creation of an Occupational Safety and Health Fund

OTA is aware of concern about recent large swings in occupational safety and health policy. Two areas—education and training programs, and research on workplace controls—have had funding reduced in the past few years. The creation of an Occupational Safety and Health Fund might provide more stable and enhanced funding.

Recent U.S. research concerning the use of "washed cotton" to control the hazards of cotton dust also provides a model for cooperative research. This project was funded by Government and industry, with oversight and direction provided by a group of labor, management, and Government officials. Jointly administered research efforts and training programs have also emerged from collective bargaining.

A fund could be established with or without a Government contribution. For example, interested citizens, employers, workers, foundations, and other groups could make voluntary contributions. Or Congress could create a fund. If it becomes a Federal activity, financing could be through a payroll tax on employers or, although this would be more difficult, through a tax or surcharge based on workers' compensation premiums (with some adjustments for the presence of health hazards in various industries). For example, a 0.1 percent employer tax on the total U.S. payroll of $1.6 trillion (in 1982) would result in annual revenues of about $1.6 billion; a 0.01 percent tax would produce $160 million. A 1.0 percent surcharge on workers' compensation premiums (about $25 billion in 1980) would produce annual revenues of $250 million. Another possibility would be to allocate fines collected for violations of OSHA standards to this fund. This would produce less money; in 1983, OSHA's proposed fines totaled $6.4 million.

Several different administrative arrangements for such a fund are available. Congress could follow the model of the Work Environment Fund of Sweden by creating a tripartite board of employers, employees, and Government representatives, or it could delegate administrative responsibilities to NIOSH, since this would be a research and information dissemination activity. The fund and its research and training projects could exist alongside existing projects and arrangements at OSHA and NIOSH, or Congress could consolidate existing research and training activities (including NIOSH extramural research grants and training grants, OSHA New Directions grants and OSHA-funded consultations) under one umbrella group.

Although such a fund would enhance the commitment to research and training, there are disadvantages to consider—primarily that this represents a new venture, with all the problems that such undertakings incur. Moreover, a new tax or surcharge, even though of modest size, runs against the desire embodied in recent legislation to reduce business taxes.

Option 27: Congress could create an Occupational Safety and Health Fund to finance research in control technology, training and education, and information dissemination.

The Needs of Small Businesses

Loans for Compliance With OSHA Standards

Small businesses are often disproportionately burdened by investments required for health and safety protection. Congress recognized this when it passed the OSH Act by also amending the Small Business Act to allow the Small Business Administration (SBA) to make loans for OSHA compliance. Between 1971 and 1981, when Congress eliminated authorization for this program, SBA processed 261 such loans. Now may be a good time to study this program to learn what effect these loans had and why so few were processed. Following such a study, Congress could consider reauthorizing the loan program.

Option 28: Congress might direct OSHA and/or SBA to study the results of SBA loans made for compliance with OSHA standards.

Shared Resources

It is inefficient and impractical to require each small business to provide a full range of health and safety services. Instead, organizations and programs to serve the needs of a number of small businesses in a given area or industrial specialty might be cost effective. Initial funding could come from OSHA or NIOSH, with the hope that these programs would ultimately be self-supporting.

The most difficult part of this option is to design a method to sustain the program after the startup period. Even though shared programs should cost less than if a company were to purchase the services entirely on its own, some small businesses might find the price beyond their means. It is unclear how to aid those companies.

Option 29: Congress might direct NIOSH and OSHA to encourage the development of shared programs to provide industrial hygiene, safety engineering, medical surveillance, and worker health and safety training for small businesses.

Changed Regulatory Approaches

Providing protection against occupational injuries and illnesses in small business establishments presents its own set of problems. It may be cost effective to treat occupational health and safety in such firms in a fashion similar to current regulation of consumer products—by regulating machines and products that small businesses purchase.

Of course, many products purchased by small businesses are also used in larger businesses, whose employees would also benefit from such regulation. An important limitation of this approach is that some occupational hazards are created in the improper installation, use, and maintenance of machines and products. This regulatory approach would have only limited impact on those hazards.

Option 30: Congress could take actions to improve the safety of products used by small business. This might include:

- *directing NIOSH to conduct tests of products used by small businesses and to publish the results in a form easily available to such establishments;*
- *encouraging OSHA, Consumer Product Safety Commission, and EPA regulatory actions concerning the products used by small businesses.*

Establishment of Occupational Medicine Clinics

In the United States, most occupational medicine is practiced in the workplace by physicians employed by industry, especially by large companies.

Changes are apparent, however, as small- and medium-sized companies are making choices between contracting with hospital-based clinics for medical care or maintaining a company medical department. The clinics may grow to fill current voids—servicing industries, regions, and employers where such services are unavailable or deficient. Clinics might, because of a larger patient load and a staff that consequently sees more patients, be able to provide more-knowledgeable care and improved physician training.

The staff of these clinics emphasize that they will provide advice about prevention as well as medical care. The combination of staff physicians, industrial hygienists, and engineers could provide a critical mass for a great deal of important activity in hazard identification and control.

Programs concerned with occupational medicine and prevention should consider and study the choices. They may alter industrial medical care and responsibilities of industry and labor, as well as the relationships between such clinics and the private practice of medicine.

Assessing Health and Safety Programs

A key final component in improving occupational health and safety is evaluating which programs to identify hazards, develop control technologies, disseminate information, and implement controls work and which programs can be improved. Assessing or evaluating efforts in occupational safety is difficult because of the many factors that influence injury rates over time. Some of these may also stymie the evaluation of occupational health activities; more importantly, because of latent periods and difficulties in recognition, it is hard to measure improvements in occupational health.

Congress in the last few years has already indicated a desire for more systematic assessment of Government activities. The Regulatory Flexibility Act of 1980, for example, requires that regulatory agencies, including OSHA, review over a 10-year period all regulations that have a significant impact on small businesses.

This principle of reviewing and analyzing existing programs might be extended to nonregulatory programs. For example, the OSHA New Directions grants program, and the NIOSH training grants programs could be assessed. In addition, periodic assessment could be specified when new programs are established. The principal disadvantage of such a requirement would be the diversion of resources from other important areas, such as hazard identification and research on control techniques.

Option 31: Congress could require periodic assessment of all occupational safety and health programs and provide funds to conduct such assessments.

Working Papers

For this assessment, OTA commissioned a number of reports on various topics concerning occupational health and safety. These contract reports, as well as two papers written by OTA staff, are being made available through the National Technical Information Service as Working Papers.

The Working Papers have been grouped into three partss. Part A includes analyses of available data, historical discussions of several topics, descriptions and critiques of the techniques of economic analysis, and a discussion of nonregulatory incentives. Part B covers descriptions of the personal protective equipment industry, theories of injury causation and control, information exchange, and worker training and education. Part C consists of five Case Studies of different occupational hazards and diseases.

Working Papers

Part A:

#1—Kronebusch, K., *Data on Occupational Injuries and Illnesses,* working paper, December 1984.

#2—Mendeloff, J., *An Analysis of OSHA Health Inspection Data,* contract report, April 1983.

#3—Corn, J. C., *Historical Perspective: The Evolution of the Definition of Certain Work-Related Illnesses,* contract report, July 1983.

#4—Kent, M., *A History of Occupational Safety and Health in the United States,* contract report, April 1983.

#5—MacLean, D., *A History of the Consideration of Economic Impacts in the Determination of the Feasibility of Standards Under the OSH Act,* contract report, April 1983.

#6—Lave, J. R., and Lave, L. B., *Decision Frameworks to Enhance Occupational Health and Safety Regulation,* contract report, February 1983.

#7—MacLean, D., and Sagoff, M., *A Critique of Cost-Benefit Analysis as a Technique for Determining Health Standards Under the Occupational Safety and Health Act,* contract report, April 1983.

#8—Harter, P. J., *Non-Regulatory Legal Incentives for the Adoption of Occupational Safety and Health Control Technologies,* contract report, April 1983.

Part B:

#9—Gough, M., *The Personal Protective Equipment and Clothing Industry,* working paper, April 1984.

#10—Springborn Management Services, Inc., *Report on Workplace Protective Equipment and Clothing,* contract report, August 1982.

#11—Purswell, J. L., and Stephens, R., *Health and Safety Control Technologies in the Workplace: Accident Causation and Injury Control,* contract report, July 1983.

#12—Priest, W. C., *Computer-Teleconferencing as a Mechanism to Improve Information Transfer for Workplace Safety and Health,* contract report, May 1983.

#13—INFORM, *Worker Training and Education Programs in Occupational Health and Safety,* contract report, November 1983.

Part C:

#14—Arndt, R., and Chapman, L., *Potential Office Hazards and Controls,* contract report, September 1984.

#15—Bleecker, M., *Carpal Tunnel Syndrome: A Case Study,* contract report, May 1984.

#16—Goble, R., Hattis, D., Ballew, M., and Thurston. D., *Implementation of the Occupational Lead Exposure Standard,* contract report, November 1983.

#17—Hickey, J. L. S., Rice, C. H., and Boehlecke, B. A., *Technologies for Controlling Worker Exposure to Silica,* contract report, August 1983.

#18—Ruttenberg, R., *Compliance With the OSHA Cotton Dust Rule: The Role of Productivity Improving Technology,* contract report, March 1983.

Assessments in Progress as of April 1985

Technology and the American Economic Transition
Load Management and Generating Technologies for Electric Utilities in the 1990s
Western Surface Mine Reclamation
Technology and Structural Unemployment: Retraining Adult Displaced Workers
International Competition in the Service Industries
Coal Leasing Amendments of 1976
Strategic Command, Control, Communications, and Intelligence Systems
New Ballistic Missile Defense Technologies
Technology, Public Policy, and the Changing Structure of American Agriculture
Technologies To Maintain Biological Diversity
Integrated Renewable Resources Management for U.S. Insular Areas
Evaluation of Agent Orange Protocol
Status of Biomedical Research and Related Technology for Tropical Diseases
Medical Technology and Diagnosis-Related Groups: Evaluating Medicare's Prospective Payment System.
Technology and Indian Health Care: Effectiveness, Access, and Efficiency
Physicians and Medical Technology: Use, Cost, and Payment Methods
Technologies for Determining Mutation Frequencies in Human Beings
Alternatives to Animal Use in Testing, Research, and Education
Reproductive Health Hazards in the Workplace
Life-Sustaining Technologies and the Elderly
Disorders Causing Dementia
Information and Communication Technologies and the Office
Federal Government Information Technology: Congressional Oversight and Civil Liberties
Intellectual Property Rights in an Age of Electronics and Information
Technologies for Disposing of Waste in the Ocean
Hazardous Materials Transportation: Technology Issues
Science Policy Special Projects
Standardized Testing as a Measurement Tool for Federal Education Policy

(NOTE: For brief descriptions of these studies in progress—see OTA booklet on "Assessment activities"—available from OTA's Publishing Office, 224-8996.)

General Information

OTA offices are located at 600 Pennsylvania Ave., S.E., Washington, DC.

Information on the operation of OTA, the nature and status of ongoing assessments, or a list of available publications may be obtained by writing or calling:

Congressional and Public Affairs Office
Office of Technology Assessment
U.S. Congress
Washington, DC 20510
(202) 226-2115

Publications Available

OTA Annual Report.—Details OTA's activities and summarizes reports published during the preceding year.

List of Publications.—Catalogs by subject area all of OTA's published reports with instructions on how to order them.

Press Releases.—Announces publication of reports, staff appointments, and other newsworthy activities.

OTA Brochure.—"What OTA Is, What OTA Does, How OTA Works."

Assessment Activities.—Contains brief descriptions of assessments under way and recently published reports.

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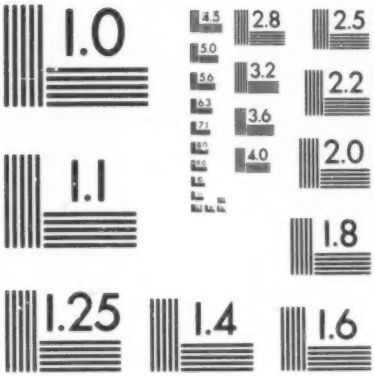

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